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Spacing among Harbour seals (*Phoca vitulina vitulina*) on haul-out sites in the Wadden Sea of Niedersachsen

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Harbour seals haul out on sandbanks, on rocks or on ice, where they form loosely gregarious herds with little visible social interaction (Bigg 1969; Godsell 1988; da Silva and Terhune 1988). In contrast to other pinniped species, such as elephant seals or walrus, they avoid close body contact when hauled out and defend their individual space by aggressive behaviour (Bigg 1981). Their grouping together is believed to be an anti-predator adaptation, granting more safety as well as more rest for the individual (Terhune 1985).

In the Wadden Sea no natural predators are known and hunting was stopped in 1972. However, during the summer months most of the Wadden Sea is used intensively as a recreational area. This leads to high antrophogenic disturbance pressure at a vulnerable time when the seals breed and moult. The objective of the present study was to document the spacing of harbour seals in order to provide basic information for future conservation measures.

In 1989 and 1990 a total of 17 survey flights were performed in Niedersachsen. All seal groups on the sandbanks were photographed at altitudes of 150 m. A Canon AE1 and Nikon F801 with a zoom of 35–200 mm and 100–200 ASA films were used. The shortest distance of each seal to its nearest neighbour was determined in "seal length" (SL). The length of the 3 largest seals was averaged on each projected slide, one SL being approximately 1.5 m (Traut 1997). Within each group, the distance to the nearest neighbour was classified as <1 SL, 1–2 SL, >2–3 SL, >3–5 SL and >5–10 SL. The midpoints of the classes were used for further calculations. All seals lying up to 10 SL apart were defined as belonging to one group. To investigate group size related variations in spacing, groups of 2–10, 11–20, 21–30, 31–50 seals ($n = 20$ each) and of >50 seals ($n = 13$) were analysed (Spearman rank correlation). Regional differences were investigated by comparing groups of 50–60 seals in the east, middle, and west ($n = 4$ groups for each region) of the study area. Because mother-pup pairs keep close body contact, they were regarded as one unit. Therefore, distances to the nearest neighbour were measured from the mother seal only. The orientation of seals in relation to the waterline was examined by allocating the direction of the seals body to one of four 90° segments. The segments were numbered clockwise, with segment I (315°–45°) being opposite the waterline, segment II (45°–135°) and segment IV (225°–315°) being sideways. A seal facing the water would be allocated to segment III (135°–225°).

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The spacing of hauled out harbour seals resulted in an average distance of 2.7 ± 0.5 SL (n = 2584) in 1990 and 2.5 ± 0.2 SL (n = 2094) in 1989. In general, we found that 27% of the seals kept a distance of less than 1 SL, 42% were 1–3 SL, and 31% were more than 3 SL apart. We found that mother-pup pairs remained within the seal groups, but they kept a distance of 3.8 ± 2.1 SL (n = 439) on average.

In our study area the seal groups were predominantly small with an average of 11 ± 16 seals (range 1–138 seals). The influence of group size on spacing was investigated by comparing the average distance in groups of various sizes. In groups of more than 50 seals the individuals were significantly ($r_s = -0.6$) closer to each other than in smaller groups (3.2 SL for < 10 seals, 2.4–2.5 SL for 11–20, 21–30, 31–50 seals and 1.9 SL for > 50 seals).

Regional differences were investigated by comparing groups of similar size (50–60 seals) on haul-out sites in the east, middle, and west of the study area. In the western part the individual distance was 1.1 ± 0.2 SL on average. About double the distance was found in the middle and the eastern part with 2.4 ± 0.3 SL and 2.9 ± 0.8 SL, respectively.

The seals occupied only a fraction of the emerged sandbanks. Generally they hauled out in a single line along the water edge. Often track marks in the sand indicated that the seals had moved from higher positions towards the waterline. We found that 54.6% of the seals (n = 3364) were facing the water (section III).

Seals in our study area kept an average distance of 2.5 SL (approximately 3.7 m) to their nearest neighbours. This varied in different areas, with seals being closer together in the western part of Niedersachsen. Even though quantification of disturbance pressure was not subject of this study, there is evidence, that especially in this area disturbance pressure is quite high during summer (TRAUT 1997). In Schleswig-Holstein, BACH and CLAUSS (1989) reported a decrease in spacing with an increase of disturbance level.

Female seals with pups did not separate from the group but the distance to other seals was larger. This is not surprising since it is known that females with pups are more susceptible to disturbances and react more aggressively than other seals (DRESCHER 1979).

We found an inverse relationship of individual spacing to group size in that seals were more densely packed in large groups. Similar results were found in a study in Schleswig-Holstein, where individual spacing decreased with increasing seal numbers (BACH and CLAUSS 1989). Since we did not observe a limitation of haul-out space, the closer grouping together could be related to higher disturbance pressure. When animals are closer packed, alarm signals from other seals could be detected faster. In Canada, large groups always had at least one vigilant animal, whereas groups of eight or fewer seals were observed to have no scanning individuals on occasion (DA SILVA and TERHUNE 1988). Taking this information, we can presume that with an average of 11 seals in Niedersachsen, at least always one of the seals is scanning the area. In our study about half of the observed seals were facing the water, which is higher than one would expect if the seals were oriented randomly. This could be another indication for disturbance pressure because it allows the seals a fast escape into the water. However, in order to quantify this, comparison with undisturbed areas would be needed, which, at this stage, we do not have.

Disturbance is an important criteria of habitat quality. If the level of disturbance influences the haul-out behaviour of seals, individual spacing as well as orientation could be used (additionally to other criteria) in judging the quality of haul-out sites.

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